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The Early Research of John B. Watson: Before the Behavioral Revolution

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John B. Watson is widely regarded as one of the most important figures in modern psychology. Despite this stature, however, presentations of his contributions and career are usually limited to material on his establishment of classical behaviorism in 1913, and then on subsequent elaborations of his position and on his study of conditioned emotional reactions. Watson's career and research prior to 1913 are rarely mentioned or cited; moreover, when this work is mentioned, the presentations often contain errors of fact. To correct these shortcomings, we present an overview of his pre-1913 research that focuses on (1) his doctoral thesis and first book, *Animal Education*; (2) his studies with Harvey Carr on the role of the various sense modalities in rats' maze learning; (3) his collaboration with Robert Yerkes on the design and construction of psychophysical equipment for the quantitative study of vision, and on experiments on the visual capabilities of monkeys, rabbits, rats, and birds; and (4) his extensive naturalistic studies in Florida on the behavior of noddy and sooty terns, parts of which anticipated better-known subsequent research on imprinting and instinctual drift. Watson's commitment to the development of an objective, natural science of behavior is clearly evident throughout his early research. In addition, his research shows that his range of interests and scientific sophistication are greater than typical descriptions of his work indicate.

John B. Watson is widely acknowledged as one of the leading figures in twentieth century psychology. Most introductory psychology textbooks contain at least a paragraph or two outlining his role in shaping modern psychology, and books on the history of psychology describe the predominance of Watson's behavioral point of view throughout the 1920s and early 1930s, up until the ascendance of Tolman, Hull, and Skinner.

For the most part, however, the material on Watson's contributions to psychology rarely go beyond describing his founding of classical behaviorism with his paper, "Psychology as the Behaviorist Views It" (Watson, 1913) and his book *Psychology from the Standpoint of a Behaviorist* (Watson, 1919). Watson's career prior to 1913 is rarely mentioned, and his empirical and conceptual contributions to psychology unrelated to the founding and promotion of behaviorism are usually not discussed. Many introductory psychology textbooks, for example, highlight Watson's "give me a dozen healthy infants" statement (Watson, 1930, p. 104), thereby potentially misleading readers about the context and more substantive aspects of his views on behavior. Moreover, writers who mention Watson's research usually limit their discussions to brief and often inaccurate accounts of Watson and Rayner's (1920) so-called "Little Albert Experiment"—"Conditioned Emotional Reactions" (Cornwell & Hobbs, 1976; Harris, 1979; LeUnes, 1983; Prytula, Oster, & Davis, 1977; Todd & Morris, 1983). Readers of typical descriptions of Watson's career could get the impression that he appeared in 1913 from almost nowhere with "Psychology as the Behaviorist Views It," and that "Conditioned Emotional Reactions" was his best or only experimental research.

When Watson's career prior to 1913 is mentioned, as in books on the history and systems of psychology, the presentations are usually brief and frequently contain a variety of errors (but see Hothersall, 1985). For example, two current texts on the history of psychology state

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incorrectly that Watson's first book was *Behavior: An Introduction to Comparative Psychology* (Watson, 1914b), published in 1914 (see Marx & Hillix, 1979, p. 131; Schultz, 1981, p. 205), when his first book was actually a version of his doctoral dissertation, *Animal Education: An Experimental Study of the Psychical Development of the White Rat, Correlated with the Growth of Its Nervous System* (1903), which was published more than a decade earlier by the University of Chicago Press. Heidbreder (1933), in her classic text, *Seven Psychologies,* stated that Watson's doctoral dissertation was published as the monograph "Kinaesthetic and Organic Sensations: Their Role in the Reactions of the White Rat to the Maze" (Watson, 1907a). Watson himself dated the beginning of that research project as the fall of 1905 (Watson, 1907a, p. 16), which was more than two years *after* he had earned his Ph.D. Heidbreder also stated that Watson became Professor of Psychology at John Hopkins in 1904 (Heidbreder, 1933, p. 240), when in fact Watson did not take the position until 1908 (Watson, 1936, p. 275). Even the most detailed Watson biography available—Cohen's *J. B. Watson: The Founder of Behaviorism* (1979)—contains enough errors of fact to call into question the scholarly value of the book as a whole (Harris, 1981; Henderson, 1981; Larson, 1981; Samelson, 1981a).

Perhaps the most objectionable oversight is that history and systems texts neither describe nor even cite much of Watson's pre-1913 writings or research. Watson's 1913 proposal to reshape psychology in accordance with his views, however, was preceded by more than a decade of intensive laboratory and field studies in comparative psychology. Indeed, Watson's classical behaviorism was taken seriously, in part, because of the stature he had achieved by 1913 through the extent and quality of his research (Bergmann, 1956; Boakes, 1984; Boring, 1950; Logue, 1978, in press-a, in press-b; O'Donnell, 1985). That the details of Watson's early career and work are unknown to most modern psychologists, including most behaviorists, is unfortunate—an important part of the development of one of the most influential schools of psychology has been ignored or distorted by historians and systematists, and more than half of the academic career of one of the twentieth century's most important psychologists has been almost completely forgotten.

We seek to redress some of these oversights and correct some of the errors by introducing the modern reader to the early research of John B. Watson. We have not attempted to provide a detailed biography of Watson's early life and career, or a critical reassessment of the past and present relevance of his work, or an analysis of how Watson's early work was related to his scholarly activity after 1913. Such material is available in the *Journal of the History of the Behavioral Sciences,* as well as in various books and chapters (e.g., Boakes, 1984; Gray, 1963; Logue, 1978, in press-a, in press-b; O'Donnell, 1985; Samelson, 1981b). What we have sought to do is to stimulate interest in and serious analysis of Watson's career by describing the wide variety of his early research and by illustrating his skills as a scientist. Because of the sheer quantity of Watson's work, along with the length and detail of many of his published reports, we cannot describe all of it in depth. What we do describe, however, is representative of the character of all of Watson's early research and illustrates the depth and scope of his scientific interests. In addition, because we wish to concentrate on descriptions of Watson's work, rather than on a critical and comparative analysis thereof, we have restricted the material on the social and scientific context of the times only to that necessary to provide a coherent biographical outline of Watson's early career. We proceed in a roughly chronological fashion, beginning with Watson's enrollment at Furman University at age 16.

FURMAN UNIVERSITY

Watson once described himself as a rebellious youth, and stated that he had never been a very good student (Watson, 1936, p. 271). For a poor student, however, Watson did very well: In 1894, at age 16 he was accepted as a "subfreshman" at Furman University, a small Baptist college in Greenville, South Carolina. At Furman, Watson met Gordon Moore who taught philosophy and psychology. Moore had spent a short time at the University of Chicago during Watson's junior year, and was probably influential in Watson's choice of graduate school and professional interests. It was Moore, though, who flunked Watson for handing in his final civics examination paper "backwards," thereby forcing Watson to spend an extra year at Furman in order to graduate. That year was not spent idly—Watson completed the requirements for an A.M. degree and graduated in 1899 at age 21 (Watson, 1936).

Watson did not immediately start on further graduate studies. Instead, between the fall of 1899 and the spring of 1900, he taught at a small private gradeschool in South Carolina called the Batesburg Institute. According to Watson, by the summer of 1899, he was interested in studying philosophy either at Princeton University or at the University of Chicago, with John Dewey. James Mark Baldwin, at Princeton, though, informed Watson their program required reading knowledge of Greek and Latin, which were two subjects Watson thoroughly disliked, but that he had done well in at Furman (e.g., in his senior year, he stated that he was the only student to pass the final Greek examination, Watson, 1936, pp. 271–272). The University of Chicago did not have this language requirement.

THE UNIVERSITY OF CHICAGO

In the fall of 1900, Watson started graduate study at the University of Chicago (Watson, 1936). He took courses in philosophy from Dewey and from Gordon Moore, who had moved to Chicago from Furman; he took courses in psychology from the functionalist James Angell and in biology and physiology from Henry Donaldson and Jacques Loeb. Watson's plans for the study of philosophy, though, faded quickly—as Watson later said of Dewey, "I never knew what he was talking about then, and, unfortunately for me, I still don't know" (Watson, 1936, p. 274). Loeb wanted Watson to conduct research on the physiology of the dog's brain, but Watson's future advisors, James Angell and Henry Donaldson did not feel "that Loeb was a very 'safe' man for a green Ph.D. candidate" (Watson, 1936, p. 273). Thus, in the fall of 1901, after a year at Chicago, Watson followed Angell and Donaldson's suggestion to "make a study of the psychical development of the white rat in correlation with the growth of its nervous system" (Watson, 1903, p. 5). This study was Watson's dissertation.

Animal Education

Watson obtained his doctorate in 1903, which was published later that year as *Animal Education: An Experimental Study of the Psychical Development of the White Rat, Correlated with the Growth of Its Nervous System* (Watson, 1903); Watson wrote that Donaldson lent him $350 for its publication (Watson, 1936, p. 273).

Animal Education was Watson's first book, as well as his first published research. It showed him to be a clear and interesting writer, as well as a careful, meticulous scientist. As one of the earliest works in experimental animal psychology, this study played a major role in lauching Watson's career as a comparative psychologist, as well as serving as a basis for subsequent studies by others (e.g., Allen, 1904; Slonaker, 1907). Moreover, *Animal Education* contains the beginnings of Watson's classical behaviorism, which was to make its formal debut a decade later in "Psychology as the Behaviorist Views It" (Watson, 1913).

The purpose of the research that became Watson's doctoral thesis was, in Watson's words, to:

> Throw some light upon the following questions: (1) How far is it possible (dealing with the psychological side of the problem) to give a systematic account of the gradual unfolding of the associative processes in the rat? (2) Is it possible (by a study of the nervous system of the rat) to find out whether or not medullated nerve fibers in the cortex of the

rat are a *conditio sine qua non* of the rat's forming and retaining definite associations? (3) Is there any demonstrable connection between the increasing complexity of the psychical life, as manifested in the ability of the rat to form increasingly complex associations, and the number of medullated fibers in the cortex, together with their extensions toward its surface? (Watson, 1903, p. 5)

These were important questions in turn-of-the-century comparative psychology. At that time, according to Watson, researchers had not demonstrated that rats could form associations except in relation to the sense of smell (Watson, 1903, p. 8). Furthermore, Watson stated that some physiologists of the time, such as Flechsig, believed that certain neurological structures, and the connections between them—the medullated nerve fibers (we would now say *myelenated* nerve fibers)—were necessary for associative learning. Such structures had been found in dogs, cats, and other animals supposedly more advanced than rats. But, because the proper structures and the connections between them had not been found in the brains of rats, Flechsig and others believed that rats could not form associations—that is, they could not learn (see Watson, 1903, pp. 6–8).

In contrast to the beliefs of the time, Watson thought that rats were "capable of forming and retaining associations comparable and not greatly inferior to associations formed by dogs, cats, and monkeys" (Watson, 1903, p. 7). His conviction was supported, in part, by the results of studies by Willard Small on the behavior of rats in puzzle-boxes and mazes (Small, 1900, 1901). As a consequence of this evidence, Watson could see that the neuropsychological theories concerning associative learning in rats were incorrect, at least for those theories of which he was aware.

In order to "give a systematic account of the gradual unfolding of the associative processes in the rat" (Watson, 1903, p. 5), Watson adopted methods like those of "Small, Thorndike, and others in their studies on the associative processes in animals" (Watson, 1903, p. 8). That is, according to Watson:

The rats were made hungry, and food was then placed before them inside some form of problem box. The general behavior of the rat in performing the act necessary to obtain the food was then noted. Besides keeping a record of their general behavior, a time record of the first, second, etc., successes was kept. The general behavior, time record, etc., of the various groups were then compared with one another, and general conclusions drawn. (Watson, 1903, p. 8)

In adopting the problem box as his apparatus, Watson was not only following the lead of Thorndike and Small, but also acknowledging its usefulness as scientific equipment. The problem box had produced reliable results across subjects and smooth learning curves for individual behavior. For example, Watson reiterated an important and surprisingly modern-sounding conclusion (see Skinner, 1981) drawn from problem-box work:

[Animals] do not learn by being put through an act. Their method of learning is a gradual selection of certain acts and movements in the given situation by reason of the satisfaction they bring. (Watson, 1903, p. 12)

Besides adopting the methods of Thorndike and Small, Watson also followed Lloyd Morgan in avoiding preconceptions about mental processes in animals by using a descriptive, inductive approach. Watson said in *Animal Education* that Morgan had begun "the method of watching the formation of associations, rather than taking them already formed" (Watson, 1903, p. 10). Watson chided Small on this point when he said that Small had applied "somewhat too much of his own conscious processes to the associative powers of the rat" (Watson, 1903, p. 9). That is, Small had attempted to think like a rat and concluded that the formation of associations could only take place if the rat's hunger were fully satisfied after each daily trial. Watson, in contrast, could find no empirical basis for Small's view and ran several trials per day per rat, each trial followed by only a small amount of food. Additional evidence for Watson's attempt to achieve a purely descriptive approach lies in the fact that he rarely seemed to use the term "association" to refer directly to mentalistic processes or to the formulation of physiological connections. The term, as he used it, was a synonym for a "habit" or "pattern of behavior."

In the first part of *Animal Education,* Watson described his research on the psychical development of rats in numerous experiments using several groups of rats and a variety of puzzle-boxes, conducted in the four months between November 19, 1901 and March 17, 1902. Most of his experiments consisted of having rats of different ages dig through sawdust to get to bread or milk-soaked bread placed in a variety of problem-boxes. Digging through sawdust from the outside to the inside of a box was thought to be behavior more closely related to the rats' behavior in their natural habitat than having them escape from a box by manipulating latches, as in Thorndike's use of the problem boxes with cats. Watson's rats were generally successful in solving the problems put before them. Watson also compared the rats' use of smell and sight in finding food by concealing cheese under sawdust or within sealed glass jars within puzzle-boxes. In order to determine the earliest stages of associative learning in infant rats, he placed baby rats, just a few days old, in a box in which each rat had to learn a path through and around a number of openings in the walls to reach its mother. Finally, to test whether the rats were following sexual odors or scent trails left by other rats, he constructed an apparatus in which rats would obtain food at the end of one of four cardboard tubes in which odors were eliminated by changing replaceable paper liners.

Watson recorded all aspects of his research in great detail. He included references to the conditions in his laboratory and to the condition of his rats before and during the trials. For example, he noted once that "When this rat was tried there was a great amount of noise made in the building by some workmen fitting steam-pipes. This caused the rat to show some signs of fear and his attention was distracted" (Watson, 1903, pp. 20–21). And, in another place, he noted that "The poor results obtained . . . were due to the fact that the members of this group had been weaned only four days and very little bread satisfied their immediate hunger" (Watson, 1903, p. 21). Such seemingly mentalistic terms as "attention" and "satisfied" were not unusual turn-of-the-century descriptors of animal behavior (e.g., Small, 1900, 1901), perhaps because the study of animal behavior was initially somewhat anthropomorphic and because adequate technical terms were otherwise lacking. Moreover, Watson not uncommonly described his rats' behavior in simple, colloquial terms that were at times quite picturesque. For instance, in describing one rat's reactions to a particularly troublesome problem, he wrote:

> This rat did not go to work at once, but *walked* around the floor, lazily sniffing at the food. (All of the rats of these three groups had been deprived of food for an equal length of time.) It then reared up on the fence and smelled at the food, then went to the top of the fence. Here it seemed to be content for a time, making only a few movements by trying to pry under the cover of the fence. Later it came down and poked its nose into the blinds, but never entered. At the end of 30 min. it was necessary to leave it at its task. On my return, 1½ hours later, I found it sitting on the fence, looking the picture of discouragement. Nothing would induce it to work any more. (Watson, 1903, p. 25)

Watson's use of such seemingly subjective terms as "content" and "discouragement" does not extend into his conclusions, however, as they did in Small's reports (see Small, 1900, 1901).

Watson's final conclusions about the "psychical development" of rats were firmly based upon his careful behavioral measurements, as well as his detailed personal observations (see Watson, 1903, pp. 84–85). He had found that rats 23 days old could solve any problem an adult rat could solve. These young rats solved problems based on "physical activity" (e.g., simply digging away sawdust to get into a goal box, Watson, 1903, p. 87) more quickly than older rats. Problems requiring more complex discriminations or choice, however, were more quickly solved by the adult rats who presumably had had more exposure to a variety of problems. Watson also noted that younger rats showed "superabundant physical activity and lack of muscular control" (Watson, 1903, p. 84) and that they continued to make useless movements in solving problems, while adult rats, in contrast, abandoned superfluous activity quickly. The amount of random activity of the young rats reached a peak at about 35 days of age and then decreased as the rats grew older.

With respect to the senses of sight and smell, Watson showed that rats primarily used smell in finding food and that scent tracking of other rats' trails did not play a role except possibly after the rats' sexual maturity. On the development of associations in young rats, he found that rats younger than 12 days could not solve his problems, but that from 12 to 23 days there "is a gradual but rapid increase in the complexity of the memory process until at the latter age psychical maturity is reached" (Watson, 1903, p. 86).

The primary object of the second part of Watson's research was "to furnish the basis for a correlation between the growth of the nervous system of the white rat and the activities of that animal" (Watson, 1903, p. 89). A secondary object was to "obtain data for a comparison between the sequence of medullation in the central nervous system of the white rat and the human foetus" (Watson, 1903, p. 89). This part of Watson's study consisted of a detailed examination of the dissected brains of 23 rats between 2 hours and 42 days of age and of one rat recorded as an "adult" (Watson, 1903, p. 90). His records of the development of medullated fibers in the rats were as detailed as those of the rats' behavior. In addition, Watson showed an impressive command of the turn-of-the-century neurophysiology. Despite a great number of dated neurophysiological technical terms, however, his descriptions of the development of the rats' brains are still quite readable.

His basic finding on these matters, at least in relation to the rats' psychical development, was that the rats were born without medullated nerve fibers, but that these fibers soon developed and increased greatly in number in the brain and other parts of the nervous system by 24 days of age. The process of medullation, however, was by no means complete by then; indeed, many of the fibers connecting those regions of the brain whose interconnections were thought necessary for conditioning to occur had not become medullated.

Watson presented his analysis of the correlation between the psychological and neurological development of the rat in the third section of *Animal Education.* He began by describing some of Small's observations on the behavior of newborn rats, noting that the baby rats were undoubtedly capable of a number of coordinated responses to a variety of stimuli (later called tropisms; see Loeb, 1918). He also reiterated that medullated fibers were not found in the central or peripheral nervous systems of rats just one day old. In addition, with a test in which the young rats crawled around obstacles to reach their mothers, he found that 10- to 13-day-old rats were capable of "forming and retaining definite associations" (Watson, 1903, p. 118), even though the nerve fibers in the rats' olfactory tract and cerebral cortex were completely unmedullated at that age. Moreover, when the rats reached their full "psychical" development at about 23 days of age, the medullation process was still far from complete. Watson's own conclusions were:

> (1) Medullated fibers in the cortex of the rat are not a *conditio sine qua non* of the rat's forming and retaining definite associations; (2) the complexity of the psychical life increases much more rapidly than does the medullation process in the cortex, psychical maturity being reached when approximately only one-fifth of the total number of fibers in the cortex are medullated. (Watson, 1903, p. 120)

Watson ended his book with a brief extension of his work to human behavior. Flechsig, the physiologist who Watson stated had believed that rats could not form associations, also believed, according to Watson, "that not until after the second month of post-natal life can intelligence begin to play any role in the life of the child" (Watson, 1903, p. 121). In this regard, Watson noted, "This statement is made in spite of the fact that Preyer and others have many indications of the intellectual awakening long before this age is reached" (pp. 121–122). Watson's extension to human behavior was that just as there was a point in the rats' development when the "psychical" development was complete despite incomplete neurological development, there may be a similar point in the development of humans. According to Watson, "At this age the individual will be teachable; he will not have the ready ability to handle difficult situations that his father has; the psychical life of the child lacks the rich and varied experiences that have come to the parent with age" (Watson, 1903, p. 122). What is perhaps most interesting here is Watson's rejection of physiological reductionism and his adherence to observation and data rather than to the theories of the neurophysiologists. Or, as Robert Yerkes (1904) put it in his review of *Animal Education,* "Dr. Watson has done a valuable piece of work in a field which has been open thus far for theorizing of neurologists and psychologists" (p. 71).

Kinaesthetic and Organic Sensations

When Watson obtained his doctorate in 1903 at age 25, he was the youngest Ph.D. that Chicago had graduated. Despite this and his magna cum laude honors, Watson reported that John Dewey and James Angell felt his final examination was "much inferior to that of Miss Helen Thompson" (Watson, 1936, p. 274), who had worked with Angell on the "organic accompaniments of conscious processes" (Angell, 1936, p. 32) and who later became Helen Thompson Wooley, the well known developmental psychologist. This negative evaluation aside, Watson was nevertheless soon offered an assistantship in experimental psychology at the University of Chicago, which he accepted.

As Watson started his work at Chicago, he was also beginning to establish a reputation within the emerging field of comparative psychology. Numerous experiments were initiated and conducted in Watson's laboratory, his equipment and methods were adopted by others, and his name began to appear in the comparative psychology literature. For example, not long after *Animal Education* had been published, Angell and Donaldson commissioned another graduate student, Jessie Allen (later Jessie Allen Charters), to conduct a series of experiments similar to those in *Animal Education,* but using guinea pigs instead of rats. That study, "The Associative Processes of the Guinea Pig: A Study of the Psychical Development of an Animal with a Nervous System Well Medullated at Birth" (Allen, 1904), was published before the end of 1904. Allen included numerous citations to *Animal Education* as the authoritative text on rat behavior, as well as references to direct suggestions made by Watson regarding the conduct of her study (see e.g., Allen, 1904, p. 305).

Not only were citations of Watson's book making his name visible in the comparative psychology literature, but earlier that year, Robert Yerkes published (1904) his favorable review of *Animal Education* in *The Journal of Comparative Neurology and Psychology.* Moreover, the same issue of the journal containing Allen's article also published an editorial by Watson (1904) entitled "Some Unemphasized Aspects of Comparative Psychology." In this editorial, Watson explained how experimental studies had answered many of the questions surrounding imitation in nonhumans that observational work could not. He concluded his editorial with a general call for greater emphasis on experimentation:

> We do plead for long and careful studies in more restricted lines than that represented by simply taking an animal and watching its general behavior. It is time to put the animal in such situations that some mental act may be exhibited to the exclusion of others. (p. 363)

So, even by 1904, Watson was making his mark on psychology by attempting to reform it to his own specifications.

At about this time, Watson met Harvey Carr, another graduate student of Angell's who was to work with Watson on his next major project, a complex, 18-month-long study of the behavior of rats in mazes. The major results of this collaboration were a monograph called "Kinaesthetic and Organic Sensations: Their Role in the Reactions of the White

Rat to the Maze" (Watson, 1907a) and an article by Carr and Watson (1908), "Orientation in the Rat."

Watson had outlined his plans for this project as early as 1904 in a paper he gave at the Congress of Arts and Sciences meeting in St. Louis. Watson stated that he wanted to determine the "relative importance of the several sensations of any given animal in its adjustment to its environment" (Watson, 1907a, p. 1). He had complained that certain problems in animal behavior had been left unanswered simply for lack of detailed knowledge of the principle avenues over which animals received their most important sensations. At that time, according to Watson, the customary approach to studying the function of the sense organs was to perform a surgical preparation on an untrained animal, and then to study the immediate and local effects of the operation. Watson noted, however, that such work, although valuable to physiology, gave "little attention to the effect of the operations on the instinctively and habitually organized reactions of the animal as a whole" (Watson, 1907a, p. 1).

In "Kinaesthetic and Organic Sensations," as in *Animal Education,* Watson modestly said that he was doing little more than extending the work of Small. Small had introduced the "modified Hampton Court Maze" in 1901 as an experimental apparatus for rats (see Small, 1901), and Watson adopted it as he had adopted the puzzle-boxes. As in his earlier research, Watson had avoided some of his predecessor's methodological errors. For example, using his detailed knowledge of rats' behavior, he explained that Small's practice of letting the rats spend the night in the maze before any recorded trails were run guaranteed the loss of any accurate record of the early stages of learning (Small, 1901, pp. 217, 230–232). According to Watson, "Any one familiar with the habits of the rat knows that 'curiosity' is the key note of his existence. A new situation means the releasing of a great amount of motor energy. This takes the form of the minute examination of all the surrounding territory" (Watson, 1907a, p. 4). The phenomena Watson was describing seems to have contained several aspects of what was later called "latent learning" (Thistlethwaite, 1951). Small, also, though, seemed to be aware that the nights spent in the maze would contribute to the measured performances, but labelled the relationship "rat-hole consciousness" (Small, 1901, p. 229).

Watson and Carr began their research in the fall of 1905 by establishing norms on maze performance with a group of normal rats, and then began their work on determining which sensations were necessary for maze learning. First, in their attempt to study the role of vision, Carr trained rats in a lighted maze, then ran them in the dark, and then trained rats in the dark and ran them in the light. In neither case did they find differences in performance within or between groups, or across conditions. Next, Carr tried to determine if visual and tactual stimuli placed at choice points of the maze would make any difference in the performances, but they did not. On the basis of these results, Watson concluded that a determination of the senses involved in maze learning could be best obtained if the contribution of the various sense organs was systematically eliminated as completely as possible.

Watson began the second part of the study in October of 1905. He used surgical techniques he had learned in the summer of 1905 under William Howell of Johns Hopkins to create three groups of rats (Watson, 1907a, p. 46). He removed the eyes of rats in one group, the middle ears of rats in another group, and the olfactory bulbs of rats in a third group. The eyeless rats were blind, of course, and the rats without olfactory bulbs seemed unable to detect odors of normal intensity; rats without middle ears, however, were not totally deaf. Characteristically, Watson recorded his surgical procedures in great detail (see Watson, 1907a, pp. 47–54). He carefully emphasized that he made the surgical conditions as aseptic as possible, that he used ether as a general anesthetic, and that the rats that had been operated upon were nearly impossible to distinguish from the normal rats on the basis of behavior alone.

With the surgery done, and the animals recovered, Watson and Carr ran these groups of rats in almost every possible combination of conditions. They tested rats from each of the three groups that had been trained in the maze prior to surgery, but found no difference in time between the performances before and after surgery. They trained anosmic and partially deaf rats in the light and ran them in the dark, and vice-versa. Again they found no difference in performance across conditions, or even when compared to normal rats. They removed the whiskers of previously trained rats from all three groups, then ran them in the maze, but again obtained no difference. At the suggestion of James Baldwin, they tested naive rats whose whiskers had been removed. As always, no operation they performed on the rats seemed to alter the animals' ability to learn or run the maze.

Watson tested the possibility that the rats were responding to subtle temperature cues, so he placed heated or cooled copper plates at various points throughout the maze. He wondered if air currents played some role, so he directed currents of air from a fan over the maze. He anesthetized the rats' noses and feet. By thoroughly cleaning the maze between runs, he even tested the possibility that the rats were responding to taste cues in the maze. Nothing, however, seemed to have any effect on the rats' performances.

Watson and Carr next examined the possibility that the rats were not responding to any cues at all, but were merely emitting one long response in running the maze. For this, Watson tested the performance of the rats after they had been placed within the maze at some point other than the accustomed starting box. If the rats were emitting one long response, they would quickly become lost as they made turns that were appropriately only when the rats started as usual. The rats in this test, however, were quickly able to orient themselves and find the food box without difficulty.

According to Watson, the inescapable conclusion of all the experiments was "that the kinaesthetic impressions coupled with certain other intra-organic impressions are the only necessary sensory factors used in the formation of the maze association" (Watson, 1907a, pp. 84–85). In a way, Watson had been studying the role of private stimulation in the behavior of animals; he had left no common public events for experimenter and rat. However, he was not completely finished.

In their next to last series of tests, Watson and Carr found a factor that did seem to have an effect on maze performance. They discovered that changing the compass orientation of the maze from the orientation during training affected the performances of almost all their rats. Some of the rats seemd to be completely lost in the maze, while others still found the food box, but hesitated at every turn and ran into walls. The decrements in performance at the changed orientation, however, usually disappeared after a few trials. Watson acknowledged that this "compass sense" was an interesting and puzzling problem, but did not feel it was adequate enough evidence to alter his basic conclusion that rats responded primarily to kinaesthetic and intra-organismic cues in learning and running the maze.

Finally, in his last test, Watson removed the eyes, middle ears, olfactory bulbs, and whiskers of one rat. He carefully monitored this rat's progress to ensure its recovery from surgery, then ran it through the maze after it had recovered. This rat would initially freeze at the slightest vibration transmitted through the maze and was slower to eliminate errors than the other rats, so consequently took a greater number of trials to learn the maze. When it did learn the maze, however, it could run through it as quickly as any normal rat. Moreover, even this rat was confused by changing the compass orientation of the maze as were all the other rats.

In contrast to Cohen's (1979, p. 42) report of this study in his biography of Watson in which Watson was reported to have prepared a "group" of rats in this way, Watson states in his article that it was necessary to make *just one* rat blind, anosmic deaf, and whiskerless. In a strong statement of support for the value of information based upon the observation of a single organism, Watson concluded his paper by stating: "If time had permitted, we should have used more than the one animal, but we believed that even this one animal established our main contention, viz., that the intra-organic sensations are the only necessary sensory factors in forming the maze association" (Watson, 1907a, p. 100).

The second paper from Watson and Carr's collaboration, entitled "Orientation in the White Rat" (Carr & Watson, 1908), was published in 1908, the year after "Kinaesthetic and Organic Sensations." "Orientation," sometimes mistakenly cited as "Watson and Carr" (e.g., Boakes, 1984, p. 268), is the more frequently cited of the two papers, but the research was primarily Carr's, and in many ways just an extension of "Kinaesthetic and Organic Sensations," so we will not describe it in detail. The study simply involved the use of blind and sighted rats, and lengthening and shortening the runways through the maze, to investigate further the kinaesthetic and organic processes involved in maze learning. In closing, we should mention that 30 years after these research projects were completed, Watson reported that he still got a "kick" out of thinking about them (Watson, 1936, p. 276).

JOHNS HOPKINS AND BIRD KEY

The Young Professor

In 1906, when Watson was completing his maze work with Carr, he was 28 years old. He was already on the editorial boards of the *Psychological Bulletin* and the *Journal of Comparative Neurology and Psychology*. By the end of 1907, he had published *Animal Education* (Watson, 1903), several research articles (Watson, 1905, 1907a), a commentary on the state of comparative psychology (Watson, 1904), and a report in *Bird Lore* on the condition of one of the Carnegie Institution's wildlife field laboratories (Watson, 1907b), as well as a book review (Watson, 1907c) and an article in the popular press (Watson, 1907d). In addition, his work had inspired other studies in comparative psychology (e.g., Allen, 1904), including one started in his laboratory that presented some of its data in the form of a cumulative record (see Slonaker, 1907, pp. 343–347).

Watson had made his mark and, in 1908, moved from instructor at Chicago to full professor at Hopkins, although reluctantly so. In Watson's words,

> I hated to leave the University of Chicago laboratory and Mr. Angell. I am sure I would not have gone had they offered me even an associate professorship. I had several researches going. I had wired the lab with my own hands, built the partitions, animal yards, and much apparatus on vision. (Watson, 1936, p. 275)

Watson left his laboratory in the hands of Harvey Carr.

Although Watson later reported that he "was lost in and happy" with his work at Hopkins (Watson, 1936, p. 276) and that he had "all the facilities I had at Chicago and more" (Watson, 1936, p. 276), he began just one entirely new animal study after his move—"The Effects of Delayed Feeding upon Learning" (Watson, 1917). All of his other comparative work had been completed by then, or at least had been initiated at Chicago. This work included a continuing series of psychophysical studies, some work with monkeys, and his most interesting and extensive research project—his investigation of the behavior of free-living sea birds in Florida. He did not, however, completely abandon comparative psychology. Besides continuing his work begun at Chicago, he contributed to the research of others by giving advice and constructing equipment (Hubbert, 1914; Watson, 1914a); he served on the editorial boards of several journals; and he wrote several extensive literature reviews (Watson, 1911a, 1912b), book reviews (Watson, 1908b, 1908c, 1908d, 1911b, 1912c), and popular articles (Watson, 1909a, 1909c, 1910b, 1912a), and of course his book *Behavior: An Introduction to Comparative Psychology* (Watson, 1914b). In addition, at Hopkins, Watson met a student of H. S. Jennings, Karl Lashley, with whom he would work extensively on several projects. To describe Watson's continuing work in this period, however, we must return to Chicago where it was begun.

Psychophysical Studies

In 1907, a committee of the American Psychological Association commissioned Robert Yerkes and Watson to devise "a standard procedure for testing color vision in animals" (Yerkes & Watson, 1911, p. 1). At the time, crude tests of color vision were performed using stimuli such as colored papers, colored yarn, and painted backgrounds. These stimuli, however, could not be standardized well enough for anything but a qualitative assessment of color vision (Watson, 1909b; Yerkes & Watson, 1911). The equipment that Yerkes and Watson developed was therefore a significant step forward in the quantitative assessment of the sensory capabilities of the animals.

Watson's responsibility for the project was to design the equipment and the methods for measuring color vision, while Yerkes was responsible for overseeing the entire project, as well as for developing equipment for testing "light vision." The equipment they designed was described in detail in their major report on the project, "Methods of Studying Vision in Animals" (Yerkes & Watson, 1911), and in a preliminary form in a study by Watson entitled "Some Experiments Bearing upon Color Vision in Monkeys" (Watson, 1909b). Yerkes and Watson described their apparatus in such detail that a well-funded and mechanically competent experimenter could reproduce it. For example, in the 1911 article, Yerkes and Watson gave instructions for mixing special glue for prisms, for grinding and polishing lenses and mirrors, and for obtaining the many custom-made lenses and mirrors they equipment required. They even included the cost of many items in the currency of the country from which the parts were obtained. Although the equipment is too complex and the descriptions too detailed to summarize, we briefly describe some of the studies on color vision in animals that Watson performed using it.

The first of Watson's studies was "Some Experiments Bearing on Color Vision in Monkeys" (Watson, 1909b). In this study, he presented a description of the apparatus he had designed, and reported on the results of a short series of experiments on the color vision of two rhesus and one cebus monkey conducted at the University of Chicago. In the first few pages of this article, he reviewed the inexact methods then used to assess color vision. Watson then described his new apparatus in great detail. In fact, nearly half of the article was devoted to the technical details of the equipment. The rest of the article described a series of studies that Watson conducted between March 12 and August 20, 1908.

Watson used a discriminated choice procedure to test the color vision of his monkeys. That is, he projected two bands of light of different colors onto a screen, one color being the "correct" choice and the other color the "incorrect" choice. A small, closed box under the correct choice contained a grape; an identical box under the other color usually did not. At the start of each trial, an opaque screen was raised and the monkey was allowed to move from Watson's shoulder to the apparatus to make the choice. If the monkey opened the box under the correct color, it was allowed to eat the grape, but if the monkey opened the incorrect box, Watson pulled the monkey back to him immediately. Watson ran many control conditions to assure that the monkeys were not making discriminations on the basis of position or were not simply going to the box in which they smelled a grape. For example, on some trials he would place a grape in both boxes so that each would smell of grapes.

Watson noted some interesting results of this study. First, he found that under his experimental conditions, the monkeys do not seem able to "see red" in a red-green discrimination; that is, instead of a red-green discrimination, they seemed to be making a green-no-color discrimination. In addition, a blue-yellow discrimination could be trained more quickly than a red-green discrimination. Second, Watson noted that when he switched a monkey to a new set of stimuli that had not been seen before, the monkey then behaved as though it had been responding on the basis of position rather than on visual cues. Third, Watson's most interesting finding was that monkeys would not take freely available food that had been placed outside the box under the incorrect choice. That is, during some of his control sessions, he placed grapes outside the box under the incorrect color choice. The monkey being tested could see the grape, but would leave it undisturbed during the trials and only eat the grapes provided as a consequence of a correct choice. Even when the monkey made an incorrect choice and examined the inside of the empty box just inches from the grape, it would not pick up or eat the food. This phenomenon in which a well trained and food deprived organism does not take freely available food, but rather only eats food that appears as a result of the programmed contingencies, is now called "contrafreeloading" (Osborne, 1977).

Watson performed several other experiments on the color vision of animals in addition to the experiments with monkeys just described. Between January 1911 and May 1912 he and his first wife, Mary Ickes Watson, conducted a series of visual discrimination studies with rats and rabbits, published as "A Study of the Responses of Rodents to Monochromatic Light" in early 1913 (Watson & Watson, 1913). In this inaccurately titled study (i.e., rabbits are not rodents), the Watsons reported that rats could not discriminate on the basis of the wavelength (color) of light alone and that rabbits probably could not discriminate colors either, but their studies with rabbits were not completed.

Another psychophysical study grew out of Watson's investigations of the homing of terns. This experiment, "Studies on the Spectral Sensitivity of Birds" (Watson, 1915), was started at Bird Key in Florida, but was actually conducted at Hopkins between August 1912 and January 1915, because the power source on Bird Key did not provide stable enough electric output for the equipment to run properly. Watson tested the spectral sensitivities of terns, pigeons, and chicks. Part of this study was designed to test the theory that birds could "home" because they could see over the horizon via infrared light which was said, according to the theory, to follow the curvature of the earth rather than being blocked by the horizon, as was light of shorter wavelength (Watson, 1915, p. 87). Regarding this theory, Watson first noted that it was, in part, the product of naive assumptions about the properties of electromagnetic radiation (Watson, 1915, p. 84), but he also demonstrated experimentally that the terns and pigeons could not see infrared light, so they were not homing by looking at their destination over the horizon. In this study, Watson also presented a graph of the visual sensitivity of a chick across the band of visible light and included a comparison graph of human spectral sensitivity. He stated that "such a curve has never been obtained hitherto on animals" (Watson, 1915, p. 96).

Watson's study on the color vision of monkeys was not his only investigation using monkeys. At the time, there was a great interest in confirming the imitative abilities in animals. Researchers had eliminated imitation as a learning process in many simpler animals, but the question remained open for more complex species. Watson published "Imitation in Monkeys" (Watson, 1908a) in 1908, reporting that he saw no evidence that monkeys could learn by imitation.

The Young Ethologist

In 1950, Konrad Lorenz, the Nobel Prize winning ethologist, stated, "If J. B. Watson had only once reared a young bird in isolation, he would have never asserted that all complicated behavior patterns were conditioned" (Lorenz, 1950, p. 233). This statement is ironic in light of Watson's having raised a number of birds in isolation from adult birds 43 years earlier as part of a detailed series of naturalistic studies, which even included a short description of imprinting, Lorenz's specialty, based on the behavior of these very birds (Watson, 1908e). Moreover, Watson's (1908e) and Watson and Lashley's (1915) studies of the behavior of birds are among the earliest ethological works cited by Lorenz's colleague and Nobel Price co-holder, Niko Tinbergen, in his classic text on ethology, *The Study of Instinct* (Tinbergen, 1951, pp. 52, 146; see also Tinbergen, 1972, p. 108). Watson, was clearly "one of the earliest and one of the most careful workers in the area of animal ethology" (Gray, 1963, p. 333).

Watson's three trips to Bird Key, Florida and his studies there of the noddy and sooty terns, as well as Lashley and Watson's (1914) observations of the day-to-day physical and behavioral development of one of the offspring of the group of monkeys Watson had brought from Chicago, were to produce a steady stream of "ethological" publications by Watson and Lashley over the next decade. These articles included: "Report of John B. Watson on the Condition of the Noddy and Sooty Tern Colony on Bird Key, Tortugas, Florida" (Watson, 1907b); "Behavior of Noddy and Sooty Terns" (Watson, 1908e); "Further Data on the Homing Sense of Noddy and Sooty Terns" (Watson, 1910a); "Notes on the Development of a Young Monkey" (Lashley & Watson, 1914); "An Historical and Experimental Study of Homing" (Watson & Lashley, 1915); "Studies on the Spectral Sensitivity of Birds" (Watson, 1915); and, by Karl Lashley, "Notes on the Nesting Activities of Noddy and Sooty Terns" (1915a) and "Acquisition of Skill in Archery" (Lashley, 1915b). As always, Watson's reports were detailed, informative, and well written. We will describe only the two articles based on Watson's first trip to Florida, however, because they represent some of the first experimental studies on free-living animals, as well as interesting observations of the mating rituals of the terns and of the role of some of the terns' naturally-occurring behavior. The scope and depth of all of Watson's ethological research is well represented by these two works.

"Report of John B. Watson on the Condition of the Noddy and Sooty Tern Colony." In 1907, at the invitation of Alfred Meyer of the Carnegie Institution, Watson spent May, June, and July as Warden of the Noddy and Sooty Tern Colony on Bird Key of the Tortugas Island Group in Florida. In these three months, Watson made an extraordinary series of observations of the island's tern population which he quickly reported in two publications, one in 1907 and the second in 1908. These observations inspired return trips in 1910 and 1913 for continued study of the birds' general behavior, as well as their homing ability, and resulted in the publications listed above.

In late 1907, Watson published the first account of his observations of the terns in *Bird Lore,* the Audubon Society Journal. In this "Report of John B. Watson on the Condition of the Noddy and Sooty Tern Colony," he reported on the number of noddy and sooty terns on the island, as well as their egg production that year. He briefly described their nesting habits and their distribution over the island (which was just 900 feet wide and 1,200 feet long). He reported his unsuccessful attempt to verify some earlier reports of nest-robbing by the island's Frigate bird. In addition, his article included a photograph of the only Least Tern found in the Tortugas Group and he warned of this bird's impending extinction in the area as a result of predation by dogs, rats, and hunters. Watson's report on the plight of the Least Tern resulted in promises for its protection from the Carnegie Institution (Watson, 1907b, p. 316).

The behavior of noddy and sooty terns. The major pubication from Watson's first stay on Bird Key was a long, detailed report of his observations and field studies on the terns. The article, "The Behavior of Noddy and Sooty Terns," published in 1908 by the Carnegie Institution, was 66 pages long, and was divided nearly equally between descriptions of the natural behavior of the birds and reports on a series of ethological field studies.

In the introduction to the paper, as in all of his previous research articles, Watson described his predecessors' work in the area and noted several discrepancies between their accounts and his own detailed observations. For example, according to Watson, one previous writer had stated that the terns had been seen swimming in the sea. Watson stated, however, that he never saw a tern in the water except after a bird had accidentally fallen in. He noted that they were such poor swimmers that they could not swim to shore against the current.

After this introduction, Watson described the birds themselves, their ranges, the island of Bird Key and the surrounding islands, the birds' feeding and mating habits, their nest construction, their behavior before and after their eggs were laid, the care of their young, and the development of the young birds. Ethologists now call this sort of complete life history of an animal an "ethogram."

Watson's characteristic attention to detail and his devotion to his projects are in evidence throughout this article. For example, he included charts in which he reported (a) almost continuous hour-by-hour time-sampling observations of the nests of six pairs of sooties, each pair sharing incubation duties for six days, and (b) half-hour observations of three nests of noddies for three days. In addition, he described rowing more than a mile out to sea at three in the morning, then waiting until dawn in his boat to determine whether the birds flew at night and when the birds started feeding in the morning.

Watson's paper provided the first good detailed reports of the general behavior of noddy and sooty terns, including their feeding and mating habits. Some of his descriptions were so new and unusual that he emphasized that some observations were tentative or even "unsatisfactory" (Watson, 1908e, p. 196). For example, before describing the mating ritual of the birds, he stated: "My notes contain a rather full account of a striking series of reactions between two noddies, which I took to be a case of mating and choice of nest site, but since it occurred late in the season and did not lead to a completed nest I advance it tentatively" (Watson, 1908a, pp. 195–196). His account of the noddies' bowing and feeding dance was most likely the first detailed description of their mating and territorial habits. Because of the brevity of the ritual, Watson suggested that an earlier presumption of J. Thomson (1903) that the noddies mated at sea before they reached the island was incorrect and that the earlier investigators had simply missed the ritual because of its brevity and because it may have occurred very shortly after the birds' arrived on the island after their migration. He was, however, unable to observe corresponding behavior in the sooty terns.

The second part of Watson's account covered his experimental studies of the birds' behavior. He started his studies by marking some of the birds with ink and oil paint to test if they were identified by their mates on the basis of appearance. These tests, however, were inconclusive because the markings on the bird elicited aggressive emotional responses and attacks from the other birds (Watson, 1908e, pp. 220–222). Next, Watson tested egg recognition by painting some of the birds' eggs or substituting fake eggs. He found that the birds would accept a painted or fake egg as readily as they accepted their own. More interestingly, perhaps, Watson discovered that placing a real or fake egg in the empty nest of a noddy tern was enough to release the full range of incubation behavior in the nesting bird (Watson, 1908e, pp. 220–223).

In his next series of tests, Watson determined that he could completely alter the appearances of a bird's nest without affecting the bird's ability to find the nest site. In addition, he found that sooty terns would find their own nests if the nests had been moved a short distance, but only after the birds had thoroughly investigated the nests' previous locations. Finally, he demonstrated how accurately the birds could pinpoint their nest sites by showing that a sooty would still alight on its own nest even after it had been raised three feet off the ground; moreover the bird would hover for a time over the previous elevated location of the nest if it were moved a few feet laterally. That is, the bird behaved as though it were trying to land on an invisible, raised nest (Watson, 1908e, pp. 224–227).

The terns were known to travel great distances in their migrations, so Watson performed some experiments on the birds' homing abilities. Very simply, he sent birds away from the island in boats in all directions, and found that they could return from locations hundreds of miles from the island. They could even return from areas in which they had never been observed to travel (Watson, 1936, pp. 227–230). These tests on homing proved to be so intresting that Watson returned twice, enlisting the aid of Karl Lashley, to perform more detailed experiments on the birds' homing abilities (Watson, 1910a, 1915; Watson & Lashley, 1915).

Watson extended his procedures to perform what may have been the earliest "operant" experiments on free-living animals (1908e). His operant chambers were puzzle-boxes constructed especially for the terns. Because he could not control the birds' feeding, he could not use food as an effective reinforcing stimulus; therefore, he used access to nests and eggs as the reinforcer for the birds, and found that the birds performed admirably in all of the puzzle box tests put before them.

Watson concluded his work by conducting a short series of maze studies using young terns he had raised by hand for the purpose. Watson described a number of maze studies which had been done earlier by Porter (see Watson, 1908e, pp. 247–248) and he adopted Porter's bird maze for his own research. Watson found that his sooty terns learned the maze faster and with fewer errors than most of the species (e.g., sparrows, etc.) tested by Porter. His noddy terns, in contrast, made more errors than the sooties. Moreover, neither kind of tern would run the maze in total darkness. Interestingly, changing the orientation of the maze, as he had done with his rats, confused the birds on their second or third trials, but rarely had any effect on the birds during the first run after rotation.

Watson compared the birds' overall performances in the maze to the skill of his rats by stating: "The terns never become the automata which the rats become" (Watson, 1908e, pp. 250–251). One important reason for the more erratic performance of the birds was interference in their maze performance by their seemingly innate behavior of standing motionless for extended periods of time. According to Watson, this naturally occurring behavior, "idling," as he called it (p. 250), whould appear from time to time after the birds had learned to run the maze, causing exaggerated and erratic performance times despite the fact that few real errors were made by the birds. Modern behaviorists may recognize this phenomenon as the "Breland Effect" (Breland & Breland, 1961, 1966, pp. 62–69), or as "instinctual drift," in which a presumably innate behavior comes to interfere with a learned performance because of similarities between aspects of the context of conditioning and the unconditioned stimuli that evoke the interfering adaptive behavior in the organism. The lack of mention of this type of phenomenon in the behavioral literature has been used by some critics of behaviorism as evidence of behaviorists' inability or unwillingness to deal with innate behavior patterns (e.g., Bailey & Bailey, 1980; Breland & Breland, 1961; Herrnstein, 1977). B. F. Skinner, himself, has attempted to counter these criticisms by suggesting that the effect that the Brelands described may have been observed by Clark Hull in Skinner's laboratory in September 1937, when Skinner's rats were seen licking marbles used as part of a chain of behavior leading to food. Skinner (1977) stated: "If Hull was right, he had anticipated the Brelands by more than two decades" (p. 1007). Ironically, the "first" behaviorist had already incorporated this effect into his own analyses of behavior 30 years before Hull commented on it and 54 years before it was reported by the Brelands and became a source of controversy.

Although Watson cannot be credited with the discovery of imprinting (see Gray, 1963), he did include a short description of it in his birds more than two decades before Lorenz's early reports (Lorenz, 1935). He noted that three-day-old sooty terns would run toward him when he appeared and would answer his "peeps." The noddies, however, did not follow or answer at this age, but by the time they were eight days old they would. As Watson commented, "The birds have formed a great attachment for me. They will follow me all around the room. It is becoming more and more difficult to keep them in any box" (Watson, 1908e, p. 240). This description of the birds' behavior is reminiscent of the common textbook photographs of Lorenz being followed by a line of young waterfowl.

Watson's article ended abruptly with the completion of his description of the maze experiments. He included no summary of results and gave no indication that his work in 1907 would inspire the several studies on homing which were to come later. As this description of the numerous experiments and detailed observations should indicate, Watson's reports on the terns were hardly as unsatisfactory or tentative as he had so humbly described them as being.

CONCLUSION

As we have seen, John B. Watson had scientific interests beyond the promotion of behaviorism. His interests extended into many areas of the investigation of behavior, including what would now be called ethology, comparative psychology, psychophysiology, neuropsychology, and, of course, behavior analysis. In his research reports, he showed appreciation for the subtleties and complexities of animal behavior, including instinctual behavior, and he reported a great deal of concern for the welfare of his animal subjects. Finally, he used his writing skills to present the innumerable details of his research in a simple, concise, and highly readable style that is not often seen in scientific publications.

We should also emphasize that certain aspects of Watson's behaviorism were evident long before his so-called behaviorist manifesto of 1913. His behaviorism did not simply appear from nowhere—it was the product, in part, of more than a decade of rigorous research on and observation of animal behavior. Although a detailed account of the interrelationships between this early research and the later behaviorist proclamations requires an analysis of Watson's work beyond the descriptions offered here, the content and style of his early work in some ways illustrates better the basic philosophy and methods of classical behaviorism than does some of his later work in which he attempted to extend his classical behaviorism into the realm of human behavior (e.g., Watson, 1930; Watson & Watson, 1928).

In conclusion, Watson's broad range of interests and multidisciplinary scientific knowledge stand in sharp contrast to most modern descriptions of him in which he is depicted as little more than an extremist promoter of a narrow philosophy of science. The history of psychology could provide a more usefully balanced and accurate view of the development of both classical and modern behaviorism by discussing Watson's rich and varied contributions to early comparative psychology and by emphasizing the unlimited range of subject matters available to behaviorists.

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